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Gas Pressure and Temperature

PROCEDURE

1. Obtain and wear goggles.
2. Put about 800 mL of room-temperature water into a third 1 L beaker.
3. Put about 800 mL of hot tap water into a fourth 1 L beaker.
4. Prepare the Temperature Probe and Gas Pressure Sensor for data collection.
    a. Connect the Gas Pressure Sensor to the USB Ports of the Computer.
    b. Connect the Temperature Probe to the USB Port of Computer.
    c. Obtain a rubber-stopper assembly with a piece of heavy-wall plastic tubing connected to one of its two valves. Attach the connector at the free end of the plastic tubing to the open stem of the Gas Pressure Sensor with a clockwise turn. Leave its two-way valve on the rubber stopper open.
    d. Insert the rubber-stopper assembly into a 125 mL Erlenmeyer flask. **Important:** Twist the stopper into the neck of the flask to ensure a tight fit.
    e. Close the 2-way valve above the rubber stopper—do this by turning the valve handle so it is perpendicular with the valve stem itself. The air sample to be studied is now confined in the flask.
5. Prepare the computer for data collection by opening the file "31 Pressure and Temp" from the *Physical Science w Vernier* folder.
6. Click Collect to begin data collection.
7. Collect pressure *vs.* temperature data for your gas sample:
    a. Place the flask into the room temp water bath. Make sure the entire flask is covered.
    b. Place the Temperature Probe into the room temp water bath.
    c. When the pressure and temperature readings displayed in the meter stabilize, click Keep. You have now saved the first pressure-temperature data pair.
8. Repeat the Step-7 procedure using the hot-water bath.
9. Prepare a boiling-water bath. Put the hot-water bath on the hot plate. Turn the hot plate to a high setting.
10. Prepare an ice-water bath. Put ice into the room temp bath.
11. Give the two new baths a while to stabilize temperature. Then continue.
12. Repeat the Step-7 procedure using the ice-water bath.
13. Use a ring stand and utility clamp to suspend the Temperature Probe in the boiling-water bath. To keep from burning your hand, hold the tubing of the flask using a glove or a cloth. After the Temperature Probe has been in the boiling water for a few seconds, place the flask into the boiling-water bath and repeat the Step-7 procedure. Remove the flask and the Temperature Probe after you have clicked Keep. **CAUTION:** *Do not burn yourself or the probe wires with the hot plate.*
14. Click Stop when you have finished collecting data. Turn off the hot plate. Record the pressure and temperature values in your data table, or, if directed by your instructor, print a copy of the table.
15. Examine your graph of pressure *vs.* temperature (°C). In order to determine if the relationship between pressure and temperature is direct or inverse, you must use an absolute temperature scale; that is, a temperature scale whose 0° point corresponds to absolute zero. We will use the Kelvin absolute temperature scale. Click on the horizontal-axis label, select "Temp Kelvin" to be displayed on the horizontal axis. Autoscale both axes starting with zero, double-click in the center of the graph to view Graph Options, click the Axes Options tab, and select Autoscale from 0 for both axes.
16. Decide if your graph of pressure *vs.* temperature (K) represents a direct or inverse relationship:
    a. Click the Curve Fit button.
    b. Choose your mathematical relationship from the list at the lower left. If you think the relationship is linear (or direct), use Linear. If you think the relationship represents a power, use Power. Click Try Fit.

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c. A best-fit curve will be displayed on the graph. Click OK. If you made the correct choice, the curve should match up well with the points. If the curve does not match up well, try a different mathematical function and click Try Fit again. When the curve has a good fit with the data points, then click OK.

17. Print a copy of the graph of pressure *vs.* temperature (K). The curve fit should still be displayed on the graph. Enter your name(s) and the number of copies you want to print.

PROCESSING THE DATA

1. What is the relationship between gas pressure and temperature in words?

2. Explain this relationship using the idea of particle speed.

3. According to your graph, what would the pressure be at 350 K (77°C)? At 200 K (–73°C)? At 400 K (127°C)?

4. Should the graph go through the origin (0,0)? Explain.